Larval Fish Entrainment at the Tracy Facility, Quantifying Spatial and Temporal Patterns of Distribution and Abundance

Investigator

Michael J Horn
Ecological Research and Investigations
Bureau of Reclamation
Denver, CO 80225
mhorn@usbr.gov

Summary

With increasing interest being placed on the continuing declines of many fish species in the San Francisco Bay-Delta area and associated San Joaquin and Sacramento River Systems, it is becoming more and more important to determine how operations of pumping facilities in the Delta might be impacting these species. Quantification of adults and larger juveniles of fishes entrained at the Tracy Fish Collection Facility (TFCF) is undertaken using a rigorous schedule of sub-sampling prior to fish being trucked to a release site (10-minute counts). While larval fish are to some degree removed from inflow waters at the TFCF and trucked to release sites, species and numbers of fish <20 mm in length are not identified counted or measured by fish diversion workers. In the early 1990's researchers conducted several tests using a continuous pump sampler and plankton nets to determine the annual intake of larval fish to the TFCF (Hiebert *et al.* 1995, Siegfried *et al*. 2000). Weber *et al.* conducted a similar entrainment study upstream in the Sacramento River at the Red Bluff Diversion (Borthwick and Weber 2001). Hiebert *et al*. further compared their data to surveys conducted by California Fish and Game during their annual larval surveys and determined there was little correlation between the samples. This was likely due to the temporal and spatial differences between sampling locations. While valuable, Hiebert *et al*'s study was conducted many years ago, and was primarily designed to assess striped bass intake at the facility, as data had suggested population declines of striped bass were correlated to pumping plan activities (CDFG 1992). Hiebert (1995) also acknowledged their sampling procedure may not have encompassed much of the lateral variability in fish densities entering the facility, as sampled at only one point near the center of the trashrack.

Since completion of these studies, fish populations in the Delta have changed significantly and these data are now likely out of date. Further, many of the questions posed by earlier studies have yet to be answered. We still don't know a lot about the correlation between tow net data in the delta and how it corresponds to larval entrainment patterns, or how tidal, diel, and spatial differences in larval abundance are reflected in entrainment patterns at the facility. Finally, we need to determine whether entrainment of larval fishes is a significant contributor to the decline of species in the Bay-Delta area. Larval fish population dynamics are becoming more of a concern in the Delta, and the presence of larval fishes near facilities could, in the near future, impact their ability to operate and/or require additional modifications to fish removal systems. Understanding the nature of the entrained larval fish community in terms of species, size and age of

fishes, and spatial and temporal differences in abundance will provide valuable information for managers looking to avoid adverse impacts to operations associated with entrainment of larval fish. This study would complement other larval work already occurring in the Delta.

Problem Statement

Larval fish samples are collected at the TFCF, and surveys are conducted in the Delta to determine the presence of larval fish. Delta fish surveys show little correlation to actual entrainment at the TFCF and with the exception of some past work, limited data exists on larval numbers entering the facility. Secondly, quantification of entrainment patterns and numbers of larval fish passing into the facility needs to occur. Finally, if it becomes necessary to develop a sampling program for larval fishes what is the best location to use for sampling to obtain an accurate representation of larval entrainment? This study will provide information on timing of entrainment, tidal, seasonal, diel and spatial dependency, and if operations impact the rate of entrainment. We will also compare data on fish entering the facility. Such data will be useful in the future as an aid to determining operational impacts on population dynamics in the Delta, and to possibly further refine adjustments to operations as larval fish populations receive further scrutiny.

Goals and Hypothesis

Goals:

1. Describe and quantify species and numbers being entrained at the facility during critical times of the year.

2. Describe seasonality and spatial and temporal patterns of larval fish distribution in and around the facility.

3. Determine how sampling different locations in the facility impacts our interpretation of larval fish entrainment.

Hypotheses:

1. If larval fish entrainment is affected by tide, time of day or season then we would expect to see differences in larval fish distribution entering the facility.

2. If operations play no role in the number of larval fish entrained then we would expect a uniform number of fish to be entrained when the action of those operations is accounted for.

3. If larval fish removal at Tracy is similar to that for larger sized fishes then we would expect to see no difference in removal rates between size classes of fish and standard count data could be used to describe larval entrainment.

4. If larval distribution is uniform in the incoming flows to the TFCF facility then we would expect to see no differences in capture efficiency between sampling locations.

5. If water in the holding tank is a representative sample of waters entering the facility then numbers of larvae sample using the holding tanks should be similar to what is sampled by nets at the entrance to the facility.

Materials and Methods

A sampling program will be developed around the use of 500-µm entrainment nets at the TFCF to determine the overall pattern, and densities of larval fish being entrained. To compare the ability of the holding tanks to characterize the influx of larval fish we will use a 500-µm screen placed over the drain to capture all fish, and compare these numbers to what is being collected near the entrance to the TFCF. Volume filtered will be standardized to the volume of water passing through the TFCF and compared to densities of fish collected from inflow waters (same methodology as used for the current 10-min counts (Karp *et al*. 1997, Sutphin *et al*. 2007). In addition we will use data and methodology from previous studies of larval entrainment to help test these hypotheses (Hiebert *et al*. 1995, Borthwick and Weber 2001, Siegfried *et al*. 2000). Data used to describe the pattern of larval entrainment was collected in 2010 and will be analyzed in FY 2011. The portion of the study comparing larvae numbers in inflowing waters to holding tank waters will be completed during VAMP in FY 2011.

To capture larval fish, drift nets were placed upstream of the trashrack at a series of locations along the debris boom. We used a series of nine-net placements (3×3 array), three top, three mid-depth, and three bottom, with sites horizontally near either edge of the intake and near the middle. Deployment consisted of 500-µm drift nets ($0.75m^2 \times 2.5m$) with attached calibrated flow meters. Based on preliminary unpublished data on debris entrainment, flow is more laminar, velocities are lower, and flow has not yet been impacted by mixing through the trashrack. The techniques of Borthwick and Weber 2001 will be used to normalize net data to account for zero counts on some net sets. A confidence interval constructed around the normalized distributions will be used to compare differences on a diel basis. A contingency table approach can be used to look at homogeneity of larval distribution across the sampling grid.

Temporal spacing of the sampling program was designed to concentrate around seasons when larval fishes are known to be present in the system with less data being collected at other times (May-June). Due to logistics we were not able to commence this study until May 2010. Within this period we will focus on obtaining data to test differences in diel distribution, tidal impacts, impacts of operational changes, spatial differences and flow changes that might occur. It is anticipated a fairly significant effort will have to be placed upon sampling to ensure significant enough numbers of larvae are captured to ensure a degree of statistical power.

During FY 2010 we sampled 1 week on, and 1 week off per month during the period of larval presence for 10 weeks of field data collection. While it is possible some pulses of fish will be missed there is an upper limit to the number of samples that can be effectively analyzed over the course of the study. Each trip two 24-h sets were run at 4-h intervals (2 day, 2 night, 2 crepuscular) for a total of 56 samples per interval. Two nights later the same procedure was repeated, but 1 h earlier. This allowed a more effective sampling of tidal differences. Samples were preserved in formalin and stored for analyses after the end of the study period, and during FY 2011.

Comparison of net data collected from the holding tanks to that collected from nets near the inflow will be done during VAMP in FY 2011. Due to budget constraints, we were notable to do this portion of the study in FY 2010. A 500-µm mesh net is placed over the drain of the holding tank to filter all water passing through the holding tank. Numbers of fish will be enumerated and standardized to flow rate and compared to net data collected at the same time using the drift net array on the debris boom. This will be one during the VAMP period when only one pump is in operation to minimize the impact of debris entrainment. Over a period of 2 weeks we will collect a triplicate date set to examine any diel or tidal differences in entrainment. We will use the same 4-h sampling windows as used for the larger scale entrainment study. Net sets will be for 30 min each period.

Coordination and Collaboration

This study will be coordinated with TFCF staff, the Fisheries and Wildlife Resources Group, and the Ecological Research and Investigations Group. Close collaboration with TFCF staff will have to occur for help in initial identification and counting of larval fish captured. René Reyes will be helping identify samples during the off season starting July 2010. Coordination with a wider spectrum of groups will occur as data are collected, and if sufficient outside interest in the project develops.

Endangered Species Concerns

There is significant potential for capture of larval stages of endangered or listed species. Permitting will have to be obtained to allow for potential take. Larvae captured during this study will already have been entrained by currents into the facility and would have been lost to the system regardless. A collecting permit will have to be obtained prior to commencement of this work

Dissemination of Results

The primary deliverables will be articles published in the Tracy Report Series and if funding is available a peer-reviewed scientific journal. It is anticipated a poster and/or technical presentation and updates will be provided at TTAT, CVFFRT, as well as at local scientific and agency meetings in the area. This knowledge will be useful in helping to guide future improvements in collection and operations of fish facilities.

Literature Cited

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